

Full Length Research Paper

Evaluating endodontic dental education by clinical errors (iatrogenic perforations) made by students in their last year of education

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The aim of this study was to evaluate the technical procedural iatrogenic errors, especially to determine the frequency of dental perforation made by undergraduate students in Sofia, Faculty of Dentistry, Bulgaria, in the school years of 2014/2015 and 2015/2016. The assessment was by examination of periapical radiographs of completed endodontically treated teeth, performed by last year dental students. A total of 748 teeth were evaluated and 30 perforations were found. From 285 treated in 2015, 10 perforations were found. From 493 teeth treated in 2016, 20 perforations were found. The overall frequency of perforations was 3.9% for 2015 and 4.1% for 2016. The frequency of perforations made by postgraduate Bulgarian students established by us is low and it is similar to that made by general practitioners and found by other Bulgarian researches. Perforation frequency found in this study is due to the large number of retreatments (36% of all cases) and the prevailing number of elderly patients with calcified canals that come to be treated in our facility. And yet it is not significantly different from other published data.

Key words: Dental education, iatrogenic perforations, quality of root canal treatment.

INTRODUCTION

The technical quality of root canal treatment (RCT) has an impact on its outcome, and consequently, in maintaining the functionality of the tooth. Endodontic treatment, like other complex dental procedures, is associated with the risk of occurrence of unexpected complications affecting the treatment prognosis. Iatrogenic errors can be classified according to the stage of endodontic treatment, and they occur as follows:

during access cavity preparation; during root canal instrumentation (ledge, root perforation, root transportation, fractured instrument); during root canal obturation (inadequate root canal filling length or density, vertical root fracture); and other accidents during root canal treatment (aspiration or ingestion, extrusion of irrigant, emphysema) (Lambrianidis, 2001).

One reason for endodontic failure is the perforation.

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This situation is characterized by a communication between the root canal system and the external tooth surface (American Association of Endodontists, 2016). It can be caused by a pathological process (dental caries, root resorption) or an operative procedural accident. Pathological perforations are found in routine clinical exams, whereas iatrogenic root perforations may occur during routine endodontic treatment (Torabinejad et al., 2018; Seltzer et al., 1970; Camilo do Carmo Monteiro et al., 2017; Rotstein, 2017; de Sousa Reis et al., 2019; Fuss and Trope, 1996; Roda, 2001; Krupp et al., 2013; Roda and Gettleman, 2016). The frequency of root perforations has been reported to range from 3% to as high as 10% (Seltzer et al., 1970; Fuss and Trope, 1996; Eleftheriadis and Lambrianidis, 2005).

Different types of root perforation (including furcation perforation, strip perforation, and apical perforation) and extrusion of the root filling materials can be detected in any area along the root. The technical quality of root canal treatments and the prevalence of associated iatrogenic errors performed in dental schools have been studied on the basis of radiographic criteria (Lambrianidis, 2001). Clinical skills play an important role in the treatment outcome. Dental students do not have proficiency and must acquire the necessary skills by exercising over time. Thus, procedural errors have a higher frequency among them.

No reports on the technical quality of root canal fillings performed by Bulgarian undergraduate dental students have been published. However, a single epidemiologic study had been performed on the technical quality of root canal fillings in Bulgarian population (Vangelov et al., 2008) and results showed good filling quality only in 29.6% of the cases.

Stamatova and Vladimirov (2004), who are investigating the frequency of perforations by general dentists through questionnaires, also found that perforations are relatively rare complications, less than 5 cases a year for a dentist. According to Kuzmanova, who researched 2460 clinical cases with endodontic treatment, the average frequency of iatrogenic perforations, made by general Bulgarian dentists is 4.06% (Kuzmanova, 2018).

The aim of this study was to determine the frequency of dental perforation made by undergraduate students in Sofia, Faculty of Dentistry, Bulgaria, in the school years of 2014/2015 and 2015/2016.

METHODOLOGY

Dental students at Sofia Medical University undertake a full preclinical course in the second and third year of their six-year training. The clinical course in the fourth and fifth year is 4 terms; it includes 30 h of theoretical lectures each year and 5 h of weekly clinical exercises during which students treat single and multi-rooted teeth.

Students performing endodontic treatments in the dental training clinic have to get every step approved by an assistant professor before proceeding to the next step. Most of the teachers supervising

endodontic treatments are specialized or specializing in endodontics.

In the sixth year, endodontic treatments are performed as part of a comprehensive dentistry-care course under the supervision of specialists, but they do not get to supervise each and every step of the process.

Radiographic evaluation is a common method for assessing the technical quality of RCT (Hansrani, 2015; Tsuneishi et al., 2005).

The data were collected from patient records and a total of 912 teeth were first included in the study. In all of these cases, RCT was performed by undergraduate dental students at Medical University, Faculty of Dental Medicine, Sofia, during the academic years 2015 and 2016. All cases with incomplete patient information, that is, missing or poor quality radiographs were excluded; the causes for exclusion were summarized. The final data comprised 778 teeth, 285 from 2015 and 493 from 2016. Conventional intraoral radiographic pictures were taken at the beginning of the treatment, during the treatment, after canal obturation, and after post-placement if the post was needed. Radiographs exhibiting superimposition of tooth structure on root canal obturation and anatomical structures were excluded from the study sample to ensure that there was no confusion in radiographic interpretation. Radiographic criteria for quality of RCT were established in accordance with the European guidelines and previous studies on the outcome of RCT performed by dental undergraduates (Eleftheriadis and Lambrianidis, 2005; Khabbaz et al., 2010).

Informed consent forms were signed by all the patients. The study was approved by the Ethics Commission for Research at the Medical University of Sofia (KENIUMUS).

All radiographs were examined independently by two researchers with more than 7 years of experience with the aid of a double-magnifying glass. Afterward, the results were compared and the researchers came to a consensus. The two examiners were calibrated beforehand after performing an experiment. Kappa values for interexaminers and intraexaminer reproducibility was approximately 80 to 90.

Statistical analysis

The data were described as frequencies and proportions as well as graphically. Cross-tabulation was used to investigate the association between the groups. The differences between the groups were tested using Z-test with Bonferroni correction, the differences between the groups were considered statistically significant when the p-value was less than 0.05. All statistical analyses were performed using SPSS 22.0 for Windows (Chicago, IL, USA).

RESULTS

During the years 2015-2016, a total of 1108 root canal fillings were performed by 6th year dental students in the Faculty of Dentistry in Sofia. The data were collected from patient records and a total of 912 teeth were first included in the study. The final data comprised 778 teeth, 285 from 2015 and 493 from 2016.

748 teeth were evaluated and 30 perforations were found. From 285 treated in 2015, 10 perforations were found. From 493 teeth treated in 2016, 20 perforations were found. The overall frequency of perforations was 3.9% for 2015 and 4.1% for 2016. Results are summarized in Tables 1 and 2.

Table 1. Total frequency of dental perforation made by undergraduate students for the period of the research.

Variable			Year		Total
			2015	2016	
Perforation	0	Count	275	473	748
		%	35.3	60.8	96.1
	1	Count	10	20	30
		%	1.3	2.6	3.9
Total	Count	285	493	778	
	% from total	36.6	63.4	100.0	

Table 2. Frequency of dental perforation made in 2015 and 2016

Variable			Year		Total
			2015	2016	
Perforation	0	Count	275	473	748
		%	96.5	95.9	96.1
	1	Count	10	20	30
		%	3.5	4.1	3.9
Total	Count	285	493	778	
	%	-	-	100.0	

Table 3. Distribution of clinical cases by type of tooth for 2015.

2015	Type of the tooth						Total	
	1	2	3	4	5	6		
Total	Count	68	29	51	42	50	45	285
	%	23.9	10.2	17.9	14.7	17.5	15.8	100.0

Table 1 shows that 285 teeth treated in 2015 represent 36.6% from all 778 teeth, 493 teeth treated in 2016 represent 63.4% of the research sample. From these teeth, 748 or 96.1% from all teeth do not have perforations (code 0). In 30 teeth or 3.9%, there is a perforation (code 1).

Table 2 shows that the overall frequency of perforations for 2015 was 3.5% from all 285 teeth treated in that year. For 2016, 4.1% of all teeth treated in that year had perforations.

For 2015 the included cases involved treatments of 68 maxillary canines and incisors (23.9%); 29 mandibular canines and incisors (10.2%); 51 maxillary premolars (17.9%); 42 mandibular premolars (14.7%); 50 maxillary molars (17.5%), and 45 mandibular molars (15.8%) (Table 3).

For 2016, the included cases involved treatments of 132 maxillary canines and incisors (26.8%); 38 mandibular canines and incisors (7.7%); 88 maxillary premolars (17.8%); 94 mandibular premolars (19.1%); 64 maxillary molars (13.0%) and 77 mandibular molars (15.6%) (Table 4).

DISCUSSION

Root canal therapy is a complex procedure. It requires competent technical skills and experience, as well as an understanding of pulp anatomy and its variations. Knowledge of root canal morphology and pulp chamber will allow the student to avoid any mishaps. Knowledge of possible errors is of great importance for the academic

Table 4. Distribution of clinical cases by type of tooth for 2016.

2016		Type of the tooth						Total
		1	2	3	4	5	6	
Total	Count	132	38	88	94	64	77	493
	%	26.8	7.7	17.8	19.1	13.0	15.6	100.0

teachers in order to avoid failure. The transition from the pre-clinical to clinical course might be very stressful and problematic for many students. It is of utmost importance that students achieve a certain level of competence over the course of their education through preclinical and clinical courses.

In previous studies, the prevalence of iatrogenic root perforations was found to range between 2.7 and 10% (Torabinejad et al., 2018; Eleftheriadis and Lambrianidis, 2005; Farzaneh et al., 2004; Ingle, 1961; Kerekes and Tronstad, 1979; Seltzer et al., 1967; Jitaru et al., 2016). In the present study, we found perforation in 3.9% of endodontically treated teeth which is comparable with results from other studies. Perforation frequency found in our study is due to the large number of retreatments (36% of all cases) and the prevailing number of elderly patients with calcified canals that come to be treated in our facility.

In their study of the outcome of endodontic treatments by dental students, Rapo et al. (2017) evaluated the quality of the root canal treatments performed by undergraduate dental students. Data comprised 105 teeth analyzed by digital radiographs. They found 3.8% (4 teeth, 3 of them in the lower jaw) of teeth had lateral perforation as a complication. In our study perforations occurred in 3.5% of all examined teeth in 2015 and in 4.1% of the teeth in 2016.

That is comparable to the results found by Mukhaimer (2013). In his study, a total of 612 periapical radiographs were used to assess the radiographic technical quality of 1013 root canals performed by the 4 and 5th undergraduate students between the years 2009 and 2012. Root perforation was detected in 47 of the 1013 canals (4.6%).

Farzaneh et al. (2004) assessed the 4- to 6-year outcome of orthograde retreatment for Phases I and II of the Torontos. In total, 523 teeth in 444 patients were re-treated. With 395 teeth lost to follow-up and 25 extracted 103 teeth (34% recall). Supervised graduate students provided treatment in accordance with a structured protocol. Presence of perforations in their study sample was 12%, but the sample included only retreatments, which explains the higher rate. In our study, primary treatment as well as retreatment cases were included.

For an optimal clinical endodontic work, updated knowledge, good training, and use of best technology are needed. It was reported in a previous study that most of the undergraduate students were not confident of

carrying out RCT of molar teeth and felt they needed extended training in the same (Moussa-Badran et al., 2008). Akhtar et al. (2016) reported strip perforation (5%), apical perforation (5%) and perforation during access (3%) in 200 root canal treatment in the permanent first molar performed by interns. So a total of 13% of cases had perforations but the case sample consisted only of permanent molars. In our study, perforations were found in 3.9% of endodontically treated teeth but our case sample consisted of all kinds of teeth: incisors and canines, premolars, first, second and third molars. Treating permanent molars can be challenging and may explain the higher rate of perforations.

Haji-Hassani et al. (2015) studied a total number of 1335 charts of the cases in the field of root canal treatment. The second most frequent error was overfilling (apical perforation) in 18.2%. They found 0.9 strip perforations and no case of furcal perforation. According to the authors, the lack of furcal perforations was due to perfect supervision. Khabbaz et al. (2010) also did not find any furcal perforations, but they reported root and apical foramen perforation in 11.8 and 32.6% of the canals, respectively. In our program, sixth-year students were supervised by 2 endodontic specialists. In 2015, there were 100 students and in 2016 there were 144 students. The ratio of supervisors: students was 1:50 in 2015 and 1: 72 in 2016. This ratio should be improved so that more careful supervision can be obtained.

The quality of education is a resultant of many factors such as time devoted to theoretical and practical teaching and training (pre-clinical and clinical), the ratio of supervisors: students, the clinical and scientific level of teachers if they are specialized or not, the teaching aids, the assessment methods, etc. Some complications can be avoided using modern technologies introduced to endodontics. However, the treatment choice depends likewise on dental equipment, skills, and knowledge, amount of tooth structure left, patient's willingness to follow the instructions, desire and economic status of the individual (Estrela et al., 2014; Unal et al., 2011).

Conclusion

The frequency of perforations made by undergraduate Bulgarian students established by us is low and it is similar to that made by general practitioners and found by other Bulgarian researches. Perforation frequency found

in our study is due to a large number of retreatments (36% of all cases) and the prevailing number of elderly patients with calcified canals that come to be treated in our facility. And yet it is not significantly different from other published data.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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